IMPLANTABLE MICROFLUIDIC DELIVERY SYSTEM USING ULTRA-NANOCRYSTALLINE DIAMOND COATING

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CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional application No. 60/272,962, filed February 28, 2001. This application is related to U.S. Patent application, Implantable Device Using Ultra-Nanocrystalline Diamond, Attn. Docket S-121, filed on even date herewith and incorporated herein by reference.

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Field of the Invention

[0002] The present invention relates to a microfluidic delivery system that is coated with an inert and impermeable thin film and more particularly to controlled time of release and rate of release, single and multi-welled drug delivery devices, which may also be implantable.

Background of the Invention

[0003] Implantable microfluidic delivery systems, as the microchip drug delivery devices of Santini, et al. (U.S. Pat. No. 6,123,861) and Santini, et al. (U.S. Pat. No. 5,797,898) or fluid sampling devices, must be impermeable and they must be biocompatible. The devices must not only exhibit the ability to resist the aggressive environment present in the body, but must also be compatible with both the living tissue and with the other materials of construction for the device itself. The materials are selected to avoid both galvanic and electrolytic corrosion.

[0004] In microchip drug delivery devices, the microchips control both the rate and time of release of multiple chemical substances and they control the release of a wide variety of molecules in either a continuous or a pulsed manner. A material that is impermeable to the drugs or other molecules to be

delivered and that is impermeable to the surrounding fluids is used as the substrate. Reservoirs are etched into the substrate using either chemical etching or ion beam etching techniques that are well known in the field of microfabrication. Hundreds to thousands of reservoirs can be fabricated on a single microchip using these techniques.

[0005] The physical properties of the release system control the rate of release of the molecules, e.g., whether the drug is in a gel or a polymer form. The reservoirs may contain multiple drugs or other molecules in variable dosages. The filled reservoirs can be capped with materials either that degrade or that allow the molecules to diffuse passively out of the reservoir over time. They may be capped with materials that disintegrate upon application of an electric potential. Release from an active device can be controlled by a preprogrammed microprocessor, remote control, or by biosensor. Valves and pumps may also be used to control the release of the molecules.

[0006] A reservoir cap can enable passive timed release of molecules without requiring a power source, if the reservoir cap is made of materials that degrade or dissolve at a known rate or have a known permeability. The degradation, dissolution or diffusion characteristics of the cap material determine the time when release begins and perhaps the release rate.

[0007] Alternatively, the reservoir cap may enable active timed release of molecules, requiring a power source. In this case, the reservoir cap consists of a thin film of conductive material that is deposited over the reservoir, patterned to a desired geometry, and serves as an anode. Cathodes are also fabricated on the device with their size and placement determined by the device's application and method of electrical potential control. Known conductive materials that are capable of use in active timed-release devices that dissolve into solution or form soluble compounds or ions upon the application of an electric potential, including metals, such as copper, gold, silver, and zinc and some polymers.